

THE USE OF ION MOBILITY SPECTROMETRY AND GAS CHROMATOGRAPHY/MASS SPECTROMETRY FOR THE DETECTION OF ILLICIT DRUGS ON CLANDESTINE RECORDS.

Brian Donnelly, Ph.D., Thomas Jourdan, Ph.D., Dean D. Fetterolf, Ph.D.
and James O. Beasley, II, MPA
Federal Bureau of Investigation, Laboratory Division, Washington, D.C. 20535

INTRODUCTION

Illicit drug distribution has over the past decade grown tremendously from simple "drug pushing" where drugs were distributed from poorly organized individuals to today's well organized and well financed "drug cartels." This change to a more "corporate-like" atmosphere has resulted in a greater use of record keeping to monitor the profits generated. The use of record keeping by drug distributors is not restricted to high level drug smugglers but is used at all levels within the distribution network. Dealers at all levels including street dealers are generally "fronted," given on consignment quantities of drugs that they in turn sell to customers thereby requiring the need for records to keep track of drug sales versus liabilities. These records because of their illicit nature are often encrypted to hide the fact that they are indeed records of drug transactions.

The creation of a handwritten notation concerning a drug transaction is normally brought on because of a purchase or sale. In a sale, this is commonly accomplished through a consignment, or the designation of a quantity to a customer to whom that amount has been "fronted." Because this activity generates a debt, it follows that an accounting for payments made, as well as new transactions completed, is only logical. One of the most common means of representing these is through an "accounting flow," in which payments are subtracted from a running balance while new sales are added to it.

The examination of illicit drug records has been they key to the prosecution of numerous federal, state and local drug cases for a number of years. The Document Section of the FBI Laboratory, through its Racketeering Records Analysis Unit (RRAU), has been involved in such analytical efforts since 1983. Detailed analytical research brought about an evolution in the systematic approach utilized in the RRAU since that time. (1-3)

The close proximity of the drugs to the records often results in trace drug evidence being transferred to the records. The detection of trace drug residue on surfaces by ion mobility spectrometry (IMS) is well documented in the literature. Ion mobility spectrometry (IMS), first introduced by Cohen and Karasek in 1970 (4), is experiencing a resurgence of interest in specific purpose detection systems because of its analytical flexibility (5). A recent book thoroughly describes the fundamentals and applications of IMS (6). Forensic applications of IMS technology from 1970 to 1989 have been thoroughly reviewed by Karpas (7).

The probative value of IMS as an investigative and forensic tool is exemplified in recent applications which have included the detection of drug micro-particulates on hands (8,9), determining cocaine in injection molded plastic (10), and use in customs scenarios (11).

The following procedure will deal primarily with the newer techniques of trace drug analysis and drug record analysis developed by the Chemistry/Toxicology Unit of the FBI Laboratory since the more traditional techniques of latent finger print analysis and document analysis are well known.

EXPERIMENTAL PROCEDURE

Document Analysis:

The initial visual examination consists of studying the documents to determine if the notations thereon relate to the buying and/or selling of a product. Figure 1 shows a typical clandestine drug record. If the answer is yes, the procedure then calls for a closer look at the type of product involved. In the case of illicit drug records, the drug(s) are not normally identified, at least to the extent that a legitimate commodity would be. However, a relationship is often found between units and corresponding prices that may be consistent with certain quantities of illicit drugs. This relationship is one of the class characteristics of illicit drug records. If the weight can be decided, this may lead to the identification of the drug that is an example of an individual characteristic. Coded or abbreviated customer names (ref. to herein as "account designation"), partial dates, and lack of product and weight identifiers are all used to compare and contrast clandestine drug records with legitimate business records.

The relationships between and among various notations are frequently found mathematically. These relationships are then carefully studied, along with application of knowledge about how illicit drugs are bought and sold. For example, conversions from one weight system to another are accomplished through commonly applied formulas recognized in these examinations. The determination of the system used may also aid in the identification of the drug involved but often requires many numerical comparisons in order for a conclusion to be reached.

Besides numerical notations, slang terms, simple accounting terminology, as well as references to weights (grams, ounces, kilos, pounds, etc.) may provide clues as to the "flow" of quantities of drugs between supplier and distributor, between distributor and customer, or among employees of a drug business. These words or abbreviations commonly include "paid," "owed," "balance," "delivered," "returned," "profit," "expenses," "incoming," and "outgoing," usually in English or Spanish. Slang terms may aid in identification of the drug, and include references to the drugs ("pot," "weed," "rocks," "crank," "crack," etc.) or descriptive terms ("mold," "wet," "shake," etc.)

Class Characteristics. In maintaining illicit drug records, dealers frequently use 28 as the approximate number of grams in one ounce. Related conversions include 14 grams in 1/2 ounce, 7 grams in 1/4 ounce, 3.5 grams in 1/8 ounce ("eightball"), and 1.75 grams in 1/16 ounce. Multiples of 28 may suggest ounce equivalents in larger quantities, i.e., 56 grams in 2 ounces, 84 grams in 3 ounces, 112 grams in 4 ounces, etc. In even larger quantities, 224 grams equals 8 ounces (1/2 pound), and 448 grams equals 16 ounces (1 pound). One pound may also be suggested by the more accurate (though still not precise) equivalent of 453 or 454 grams. Such variations may be encountered even within the same set of documents.

In like fashion, the breakdown of kilogram weights into gram quantities is often made in easily recognized patterns. With 1,000 grams in a kilogram and 500 grams in 1/2 kilo, it follows that 1/4, 1/8, and 1/16 of a kilo could be recorded as 250, 125, and 62.5 grams respectively. Actually, these types of references are noted frequently in clandestine drug records.

In records of large-scale, multi-kilo cocaine distribution records, three general types of documents are often encountered. First, an inventory of incoming and outgoing kilos may provide a summary of the quantities received and distributed by the business over a specific period. Second, individual account pages show the debts incurred and payments made by various customers. Third, the business's cash ledger may show payments received from customers or employees as well as expenditures by the business. These may include office transportation and utility expenses as well as larger amounts deducted as payments to the business's cocaine supplier or for laundering purposes.

Individual characteristics. Sometimes the markings on kilo packages of cocaine (which serve as product identifiers, or brand names) are recorded as part of the inventory procedure. These may be studied for possible relationships between various search locations and links to seizures of cocaine or records seized in connection with previously unrelated investigations. These markings may consist of stickers, logos, symbols, or names (some common ones include "Rolex," "Baby," "Cartier," and "Leon.") Such specific indicators as these are examples of individual characteristics of illicit cocaine distribution records.

Marijuana records may detail inventories and distribution of hundreds or even thousands of pounds. Marijuana package weights in such documents often show pounds recorded to the left of a decimal point and ounces to the right. For example, 10 1/4 pounds might be expressed as "10.4" or "10.04." A determination that this is so might entail repeated checks of the computations noted to compare totals. If totals are in dispute, this may explain how the totals were calculated in ways unique to illicit marijuana distribution businesses.

Coded Records. Although illicit drug records are not always deliberately encoded, they often appear cryptic in nature. This is usually due to the absence of certain notations that would make them more meaningful. For example, writers often drop zeros in recording large amounts of money, possibly because including them is simply too cumbersome and time-consuming. Thus, \$23,500 as a price for one kilo of cocaine might be written as "23.5." Mathematical proof that zeros have been dropped may be found when the writer mistakenly records the full notation, or through calculations made to show partial payments such as "\$21,357."

In addition, simple substitution ciphers may be utilized by drug dealers or their bookkeepers. These are frequently based on 10-letter key words that contain no repeated letters. These may then be used to substitute for digits in telephone numbers or in the accounting records themselves. For example, the letters "M-O-N-E-Y-T-A-L-K-S" might be substituted for the numbers 1 through 9 and 0. Breaking such codes may be possible through mistakes made by the writer or through mathematical computations.

Instrumental Analysis

Ion Mobility Spectrometry. A sample to be examined is vacuumed using a standard vacuum with an attachment specifically designed to allow the collection of drug residue on a Teflon filter (4 micron mesh). Following the collection of the residue from the subject document the filter is removed from the vacuum and placed (see figure 2) into the sample holder in the Ionscan, an ion mobility spectrometer for analysis. Analysis is accomplished by heating of the filter at a temperature of 250 degrees Centigrade for four seconds to volatilize the analyte. Figure 3 shows a block diagram of the IMS. The analyte enters a chamber where ionization of the drug is accomplished under atmospheric conditions. The ions that are formed are then pulsed into a drift tube (see where they are separated in time and detected at the collector. Identification of a drug is determined by the time in milliseconds that an ion takes to transverse the drift tube in relation to an internal standard, nicotinamide that is analyzed simultaneously. The collection and display (see figure 4) of data are accomplished using a notebook computer linked to the Ionscan via an interface card.

Gas Chromatography/Mass Spectrometry. After a sample is determined to contain a drug the filter is again placed into the vacuum and the specimen in question is vacuumed a second time and the filter extracted with methanol. The extraction of the filter is accomplished by removing the filter from the filter holder and placing it into a small test tube. To the test tube is added approximately two milliliters of methanol and the test tube vortexed for thirty seconds. After vortexing of the sample the filter is removed and the methanol evaporated to dryness under a stream of nitrogen at sixty degrees centigrade. The resulting residue is reconstituted using fifty microliters of methanol and analyzed via GC/MS utilizing a Finnigan 4500 fitted with a six-foot 3% OV-17 and programmed from 60 to 270 degrees Centigrade at 25 degrees Centigrade per minute. The mass spectrometer is operated in the chemical ionization mode, using

methane as a reagent gas. Figure 5 shows the positive ion chemical ionization mass spectrum of cocaine.

Confirmation of cocaine is also accomplished through solid probe-tandem mass spectrometry. The cocaine residue is introduced into the ionization chamber through a direct solids' probe. The probe is heated from 0 to 300 degrees Centigrade at a rate of 100 degrees Centigrade per minute thereby volatilizing the cocaine and ionization in the presence of the reactant gas methane. The resulting $M + 1$ ion, m/z 304, is subsequently separated by the first quadrapole from the other ions formed. After separation the 304 m/z ion is accelerated and collided into argon gas in the second quadrapole causing fragmentation (daughter spectrum) which is detected in the third quadrapole. Figure 6 shows the daughter spectrum of cocaine.

CONCLUSION

It should be noted that forensic examinations of illicit drug records are made exclusively through comparison of all of the documents contained in a given submission taken as a whole. Isolating individual notations outside their contextual relationships to other notations in a group of documents may lead to difficulties in interpretation and severely limit the benefits to the investigating agency.

Forensic techniques of the types described above have been used effectively in many so-called "no-dope" conspiracy cases, and it is in these investigations that they can become the most important element of the prosecution. Expert testimony in this area has proven helpful in providing summaries of the activities of many illicit drug businesses as well as in describing the scope of such organizations, often in great detail. Coupled with other items of factual and circumstantial evidence, it can be a powerful tool for both investigators and prosecutors.

The analysis of the records themselves for traces of the drug being distributed lends further evidence that the notations determined by visual inspection are indeed records of drug transactions and not related to some other type of business records. The combination of these with other forensic techniques such as hair and fiber analysis, latent fingerprint analysis and traditional document analysis offer new techniques to combat the increasingly more sophisticated drug distribution networks.

REFERENCES

1. Jensen, C.J. The Forensic Analysis of Clandestine Drug Records. *Forensic Science International* **66**, 33-40 (1994).
2. Beasley, J.O. The Analysis of Illicit Drug and Money Laundering Records. *The Narc Officer*, October 1990.
3. Beasley, J.O. The Forensic Examination of Illicit Drug & Money Laundering Records, January/February 1992.
4. Cohen, M.J., Karasek, F.W. Plasma Chromatography - A New Dimension for Gas Chromatography and Mass Spectrometry. *J. of Chromatogr. Sci.* **8**, 330-337 (1970).
5. Hill, H.H., Siems, W.F., St. Louis, R.H., Ion Mobility Spectrometry. *Anal. Chem.*, **62**, 1201-1209 (1990).
6. Eicman, G.A. and Karpas, Z. Ion Mobility Spectrometry. CRC Press, Boca Raton, FL, 1994, pp 148-149.

7. Karpas, Z., Forensic Applications of Ion Mobility Spectrometry. *Forensic Sci. Rev.* **1**, 104-119, (1989).
8. Lawrence, A.H., Detection of Drug Residue on the Hands of Subjects by Surface Sampling and ion Mobility Spectrometry. *Forensic Sci. Int.*, **34**, 73-78 (1987).
9. Nanji, A.A., Lawrence, A.H., Mikhael, N.Z., Use of Skin Sampling and Ion Mobility Spectrometry as a Preliminary Screening Method for Drug Detection in an Emergency Room. *Clin. Toxicol.*, **25**, 501-515 (1987).
10. "Cocaine Smuggled as Ingredient in Plastic," *Chemical and Engineering News*, July 8, 1991.
11. Chauhan, M, Harnois, J., Kovar, J., Pilon, P., Trace Analysis of Cocaine and Heroin in Different Customs Scenarios Using a Custom-Built Ion Mobility Spectrometer. *Canadian Soc. of Forensic Sci. J.*, **24**, 43-49 (1991).

Ventas	Costo	Reserva	Entregas
7 = x 135	4 1/2 = x 90	12.5	
4 1/2 = x 103	6 = x 120	16	500
1 = x 20	45 = x 900	22	200
1 1/2 = x 35	5 = x 100	22	1000
3 = x 60	1 = x 25	13	400
1 = x 20		22	300
4 = x 100		22	500
2 = x 44		22	500
1 = x 25		22	900
14 = x 294		22	4300
2 = x 44			169
1/2 = x 11		217 1/2	446.9
48 = x 1055		22	
4 1/2 = x 90		239 1/2	
2 = x 50			
0 = x 120			
1 = x 25			
2 = x 50	TOTAL	210	
2 = x 50		26	
1 = x credit	4389	236	
3 1/2 = x 71			
5 = x 115			
2 = x 40			
2.8 = x 560			
1/2 = x cash			
1 = x 12			
1 = x 25			

139

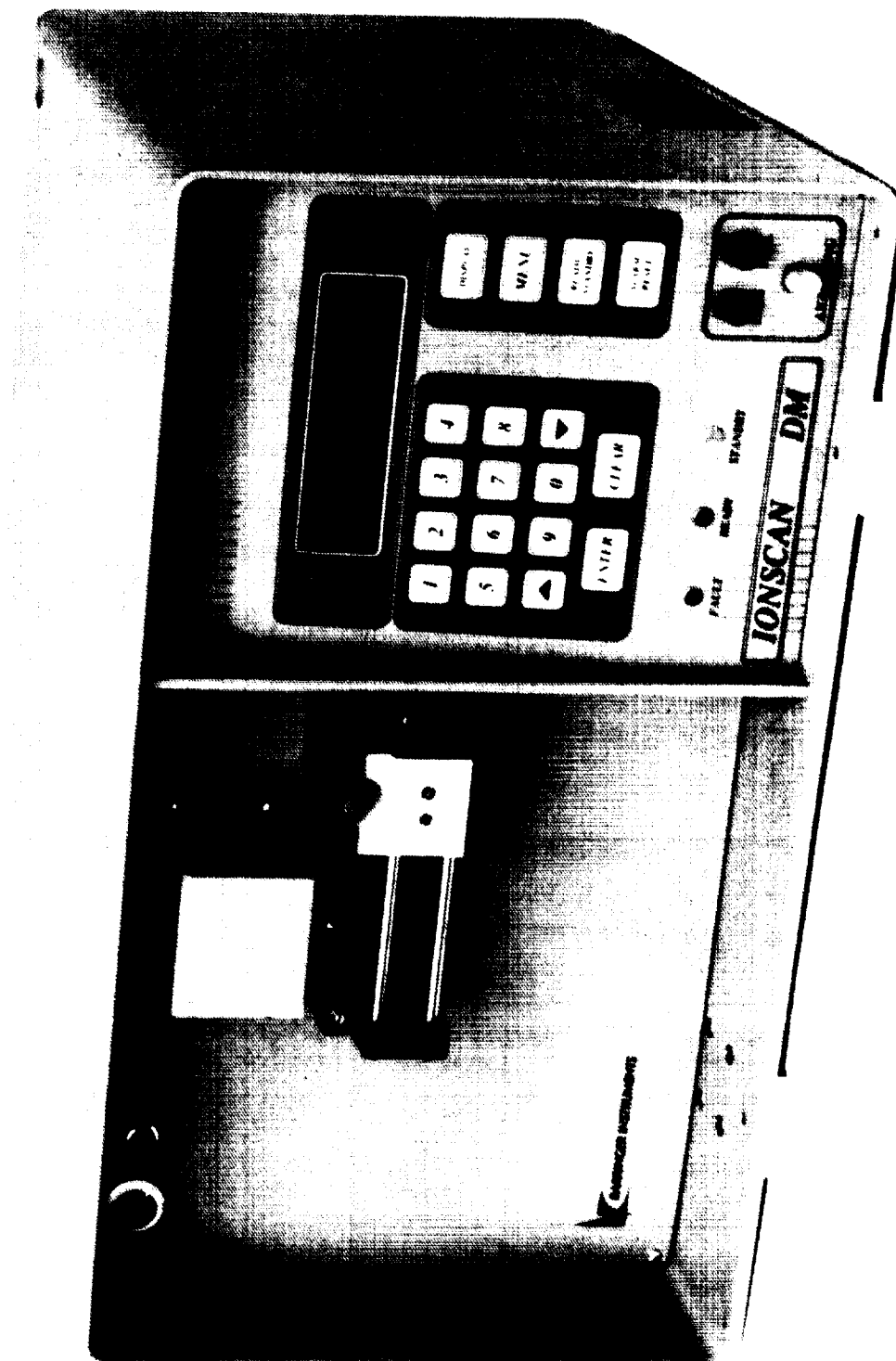


Figure 2. Photograph of the ion mobility spectrometer.

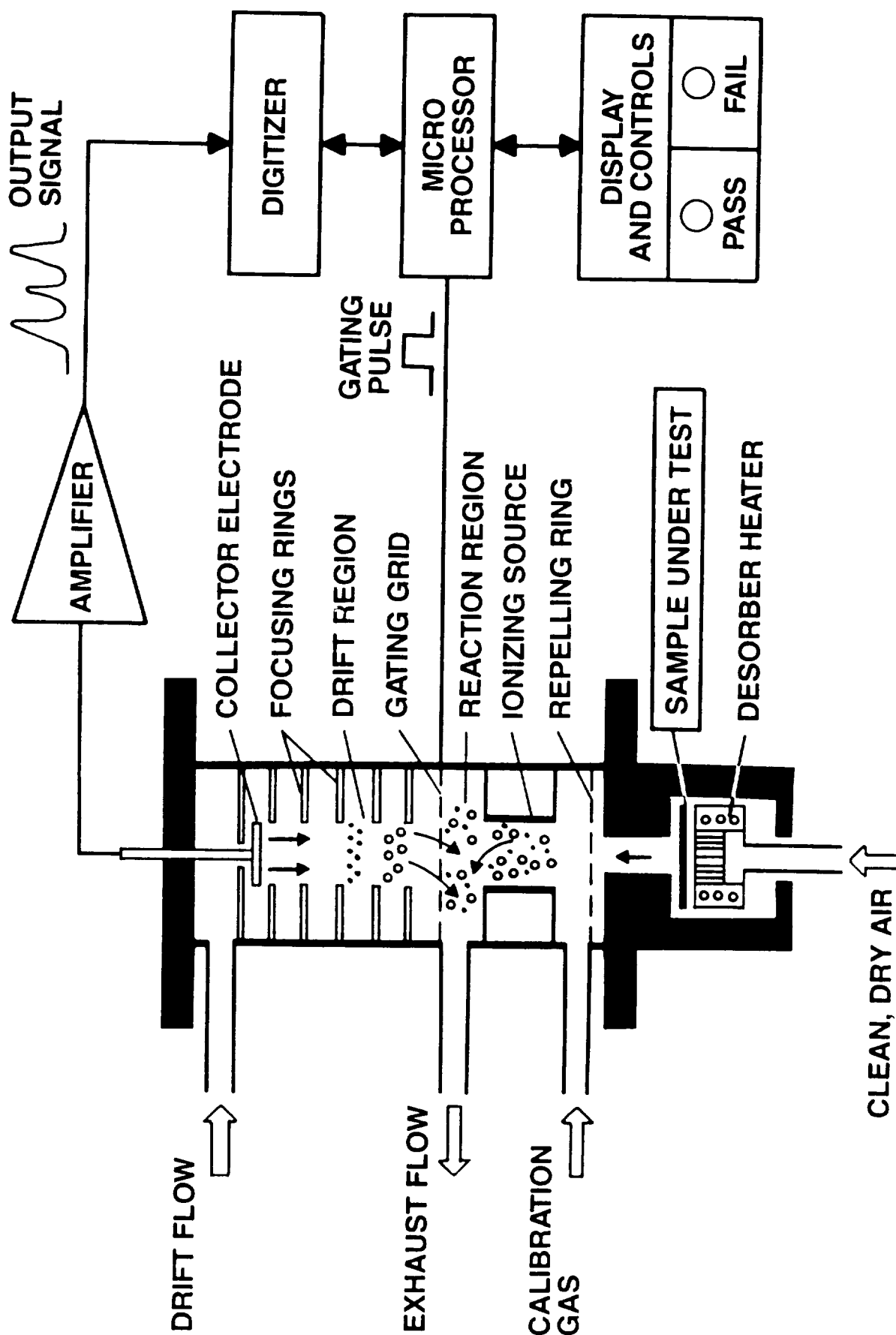


Figure 3. Block diagram of the ion mobility spectrometer.

PK#	PeakID	Ko	DTime
0*	Ca1	1.8725*	9.555
1	COCAINE	1.1600*	15.424 *
2	HEROIN	1.0407*	17.192
3	AMPH-S	1.6750*	10.677
5	METHAMPH	1.6431*	10.889
7	MDMA	1.4706*	12.166
8	THC	1.0475*	17.080
9	PROCAINE	1.3085*	13.673
10	PCP	1.2683*	14.107

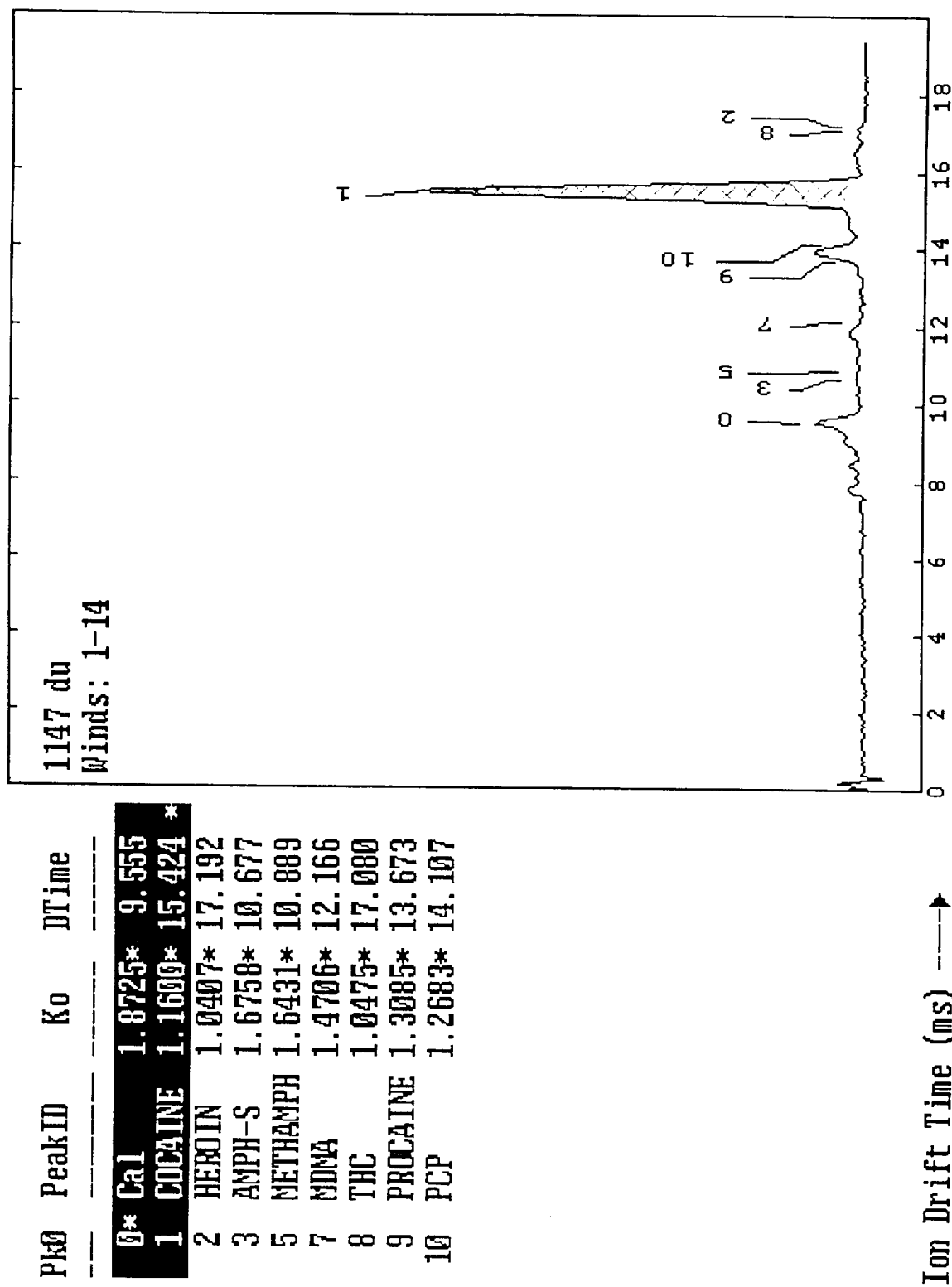


Figure 4. Plasmagram showing the detection of cocaine.

SPEC: EH ver 12 on UIC 002002 S-OCT-94 Elapse: 00:00:30.7 30
 Samp: COCAINE Start : 15:06:30 51
 Comm: STANDARD
 Mode: CI +Q1MS LMR UP LR
 Oper: EH
 Base: 304.2 Inlet : 107960
 Norm: 304.2 Masses: 70 > 370
 Peak: 1000.00 mmu # peaks: 251

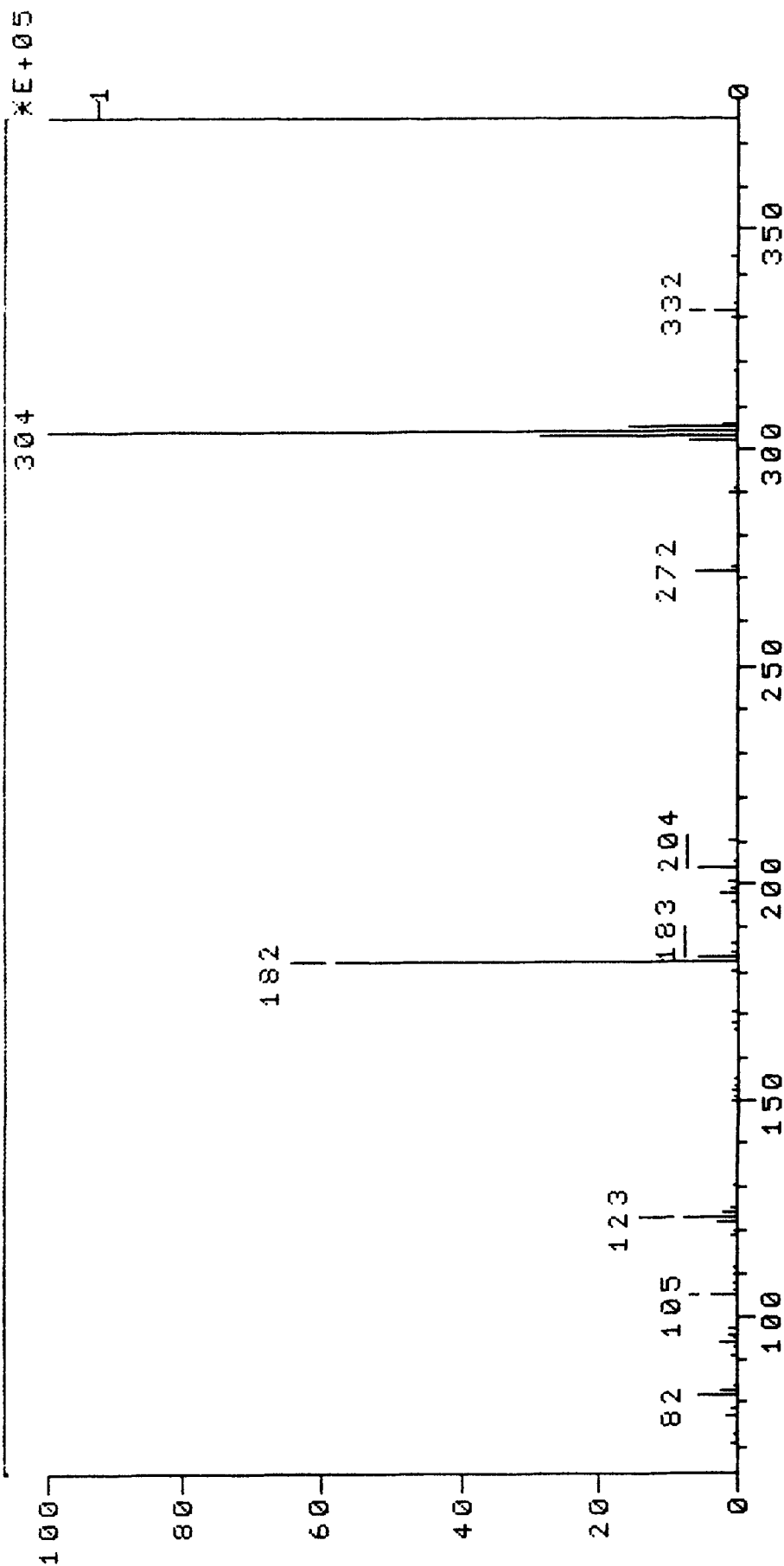


Figure 5. Chemical ionization mass spectrum of cocaine.

SPEC: EH ver 13 on UIC 002002 5-OCT-94 Elapse: 00:01:19** 71
 Samp: COCAINE Start : 15:09:37 85
 Comm: STANDARD
 Mode: CI +DAU 304.0 @ -15eV LMR SYNTH GAS UP LR
 Oper: EH
 Base: 182.1 Inlet :
 Norm: 182.1 Inten : 1520884 Masses: 80 > 310
 Peak: 1000.00 mmu RIC : 3403998 # peaks: 79

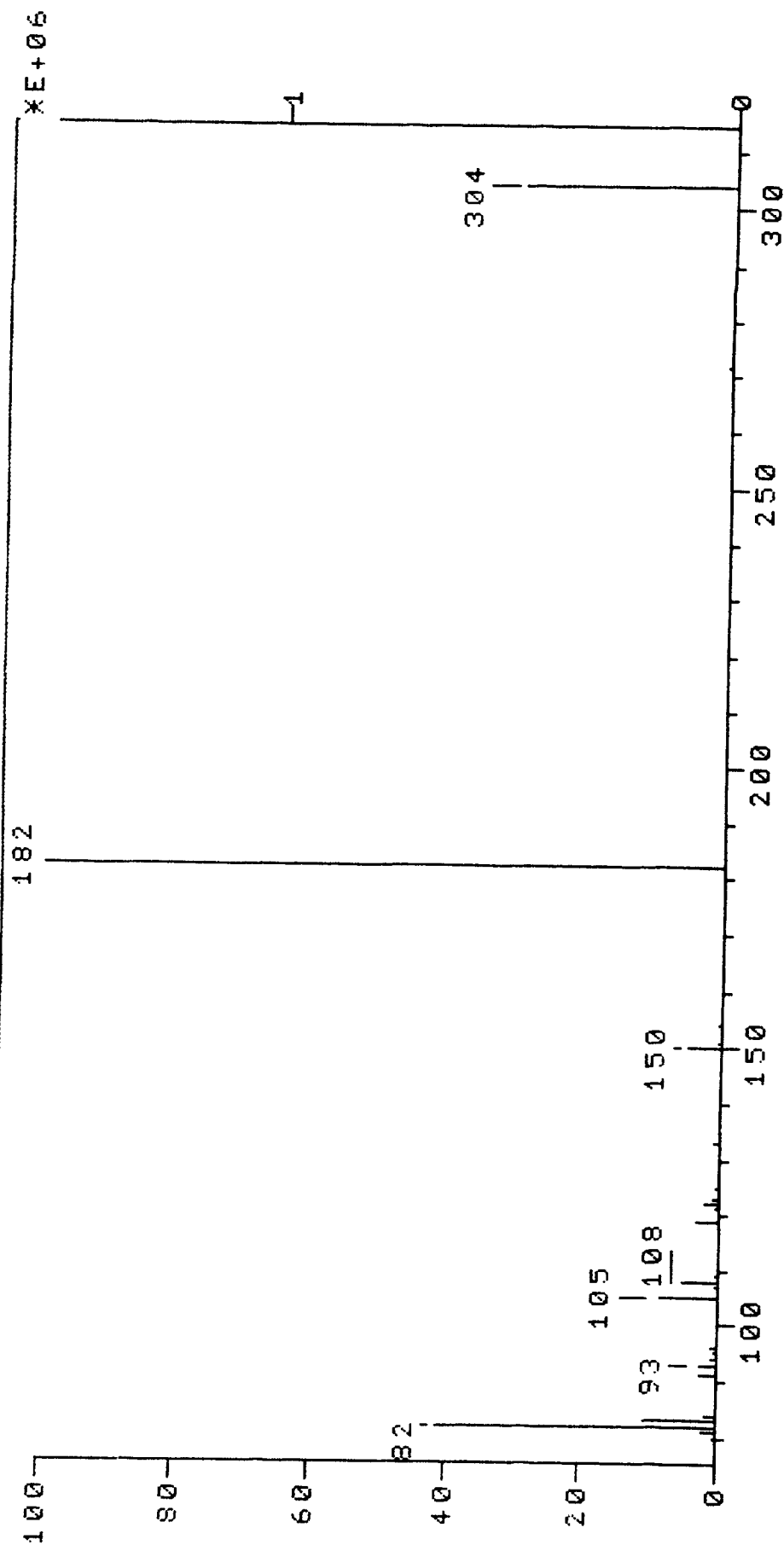


Figure 6. MS/MS daughter ion spectrum of cocaine.